



A new rhabdiasid species from *Craugastor occidentalis* (Anura: Brachycephalidae) from Sierra de Manantlán, Jalisco, Mexico

Una especie nueva de rhabdiásido de *Craugastor occidentalis* (Anura: Brachycephalidae) de la sierra de Manantlán, Jalisco, México

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Abstract. *Rhabdias manantlanensis* n. sp., parasite of the lungs of *Craugastor occidentalis* is illustrated and described. *Rhabdias manantlanensis* differs from related species in the genus by the combination of the following characters: elongated body, cuticle slightly swollen (thin and smooth), 6 weakly developed lips (4 submedian + 2 lateral), localization of nerve ring at 193-244 (220) μm from anterior end, muscular corpus slightly inflated, esophagus length/ body length ratio 5.11-6.57 (5.79%), tail relatively small, conical and with sharp terminal point, tail length/ body length ratio 1.48-3.27 (2.48) %, slightly pre-equatorial vulva (vulva length / body length ratio 41.66-51.59 [47.74] %), and cup-shape buccal capsule (11-19 [13] x 19-27 [21]). This is the seventeenth species of the genus *Rhabdias* described in the Neotropical realm and the third described in the Sierra Madre del Sur, Mexico.

Key words: Anura, *Craugastor occidentalis*, taxonomy, lung worm, *Rhabdias manantlanensis* n. sp., Sierra Madre del Sur, México.

Resumen. Se describe e ilustra *Rhabdias manantlanensis* n. sp., parásito pulmonar de *Craugastor occidentalis*. *Rhabdias manantlanensis* difiere de las otras especies relacionadas del género por la combinación de los siguientes caracteres: cuerpo alargado, cutícula ligeramente ensanchada (delgada y lisa), 6 labios débilmente desarrollados (4 submediales y 2 laterales), localización del anillo nervioso a 193-244 (220) μm de la región anterior, corpus esofágico ligeramente ensanchado; relación longitud del esófago/ longitud corporal 5.11-6.57 (5.79) %, cola relativamente pequeña, cónica y con una terminación en punta, relación longitud de la cola/ longitud corporal 1.48-3.27 (2.48) %, vulva ligeramente pre-equatorial (relación longitud de la vulva/ longitud corporal 41.66-51.59 [47.74] %), y una cápsula bucal en forma de copa (11-19 [13] x 19-27 [21]). Con ésta son 17 especies del género *Rhabdias* descritas de la región neotropical y la tercera en la Sierra Madre del Sur, México.

Palabras clave: Anura, *Craugastor occidentalis*, taxonomía, parásito pulmonar, *Rhabdias manantlanensis* n. sp., Sierra Madre del Sur, México.

Introduction

Fifteen of about 60 species of the cosmopolitan genus *Rhabdias* Stiles and Hassall, 1905 are parasites of the lungs of anurans in the Americas. There are 4 Nearctic species, *R. americanus* Baker, 1987, *R. joaquinensis* Ingles, 1935, *R. ranae* Walton, 1929, and *R. bakeri* Tkach, Kuzmin and Pulis, 2006 and 11 Neotropical species, *R. alabialis* Kuzmin, Tkach and Brooks, 2007, *R. androgyna* Kloss, 1971, *R. elegans* Gutierrez, 1945, *R. fülleborni* Travassos, 1926, *R. hermaphrodita* Kloss, 1971, *R. mucronata* Schuurmans Stekhoven, 1952 (species inquirenda, adults

unknown), *R. tobagoensis* Moravec and Kaiser, 1995; *R. truncata* Schuurmans Stekhoven, 1952 (species inquirenda, adults unknown), *R. savagei* Bursey and Goldberg, 2005, *R. pseudospherocephala* Kuzmin, Tkach and Brooks, 2007 (= *R. sphaerocephala* of Bravo-Hollis and Caballero, 1940, Brenes and Bravo-Hollis, 1959, and Kloss, 1971, 1974), and finally *R. kuzmini* Martínez-Salazar and León-Règagnon, 2007.

According to Martínez-Salazar and León-Règagnon (2007), 8 species of this general group have been recorded in México: *Rhabdias americanus*, *R. elegans*, *R. fülleborni*, *R. ranae*, *R. savagei*, *R. cf. sphaerocephala* (= *R. seudospherocephala* -records of Bravo-Hollis and Caballero, 1940), *R. tobagoensis*, and *R. kuzmini*.

The Sierra de Manantlán Biosphere Reserve is located in the transition of the Nearctic and Neotropical realms and encompasses parts of the Sierra Madre del Sur (SPP, 1985). Studies of the parasite fauna of wild vertebrates in the Sierra de Manantlán, Jalisco, Mexico are practically nonexistent. There is only one study in the region, examining helminths of freshwater fish (Salgado-Maldonado et al., 2004).

The aim of this paper is to describe a new species of *Rhabdias* parasitizing an endemic anuran of the Sierra de Manantlán, Jalisco State, Mexico, as part of a biodiversity inventory of parasites of amphibians and reptiles in México.

Materials and methods

On June 15, 2003, 2 specimens of *Craugastor occidentalis* Taylor, 1921 were collected in Puerto los Mazos, Rancho los Mojos, in the Sierra de Manantlán, Jalisco State (19°41'18" N, 104°23'43" W; 1687 m). Anurans were collected by hand, and then deposited in herpetological bags for their transportation. Hosts were killed by intraperitoneal overdoses of sodium pentobarbital. Each host was subsequently necropsied, and the organs were examined for helminths using a stereomicroscope. Lung worms were initially placed in saline (0.65%), and afterwards killed by immersion in hot 4% formalin and stored in 70 % ethanol. Nematodes were cleared with glycerin in temporary preparations. Drawings were made with the aid of a drawing tube. Measurements are given in micrometers (μm) unless otherwise stated. Minimum and maximum values are given followed by mean and SD in parentheses. Taxonomic determinations at specific level were made comparing with original descriptions and specialized literature. For the scanning electron microscopy (SEM), specimens were stored in 4% formalin, dehydrated in a series of gradual alcohol, and critical point dried with carbon dioxide. Specimens were coated with a gold-palladium mixture and examined in a Hitachi S-2460N scanning electron microscope at 15kV.

Voucher specimens of hosts were deposited in the Herpetological Collection, University of Texas in Arlington, Texas (UTA). Holotype and paratypes are deposited in the Colección Nacional de Helminthos (CNHE), Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City, México.

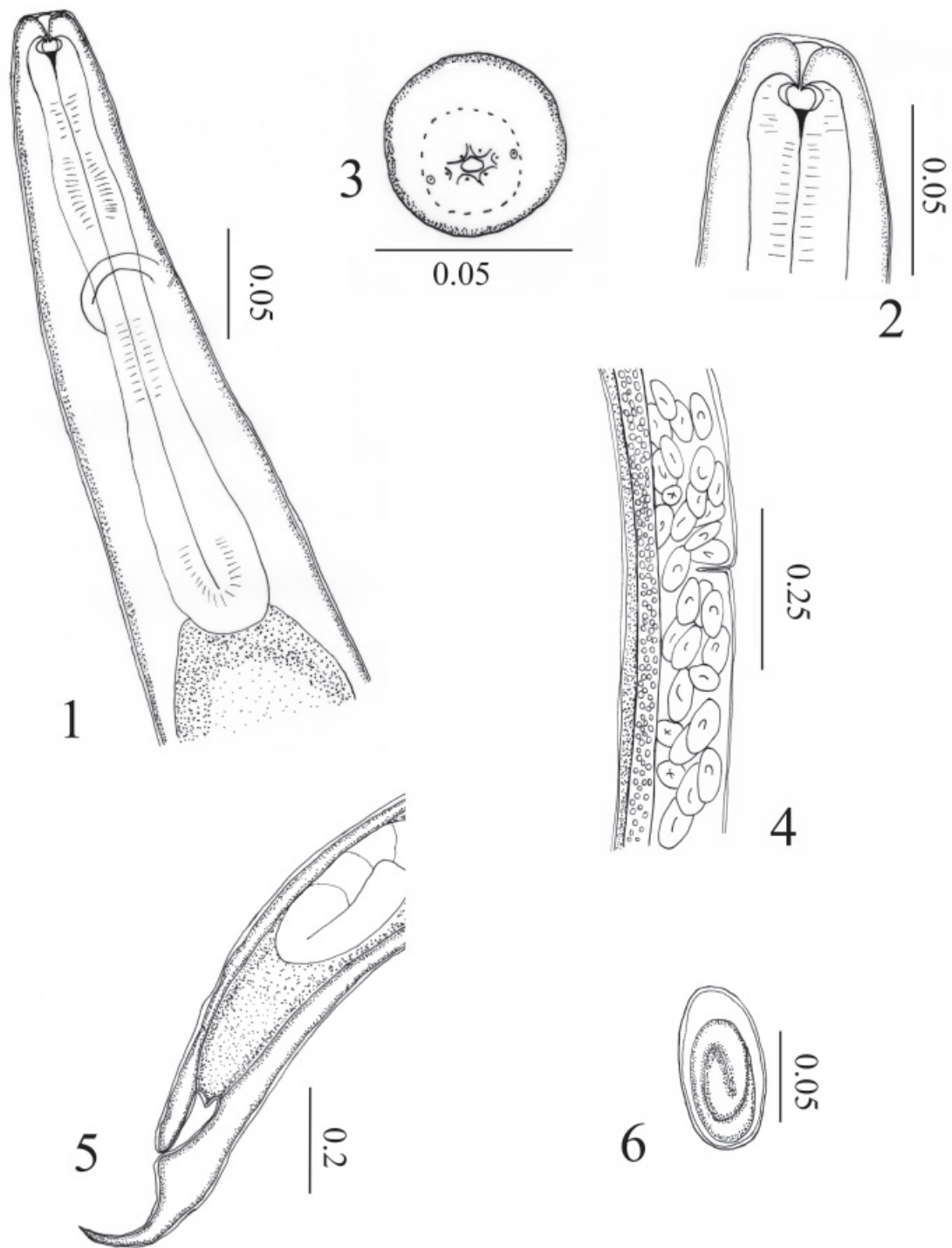
The following specimens were also examined during this study: *Rhabdias agkistrodontis* Sharpilo, 1976 (USPNC 092278.02), *R. ambystomae* Kuzmin, Tkach and Snyder, 2001 (USPNC 082125.02), *R. alabialis* Kuzmin, Tkach and Brooks, 2007 (USPNC 098144.00), *R. americanus* Baker, 1987 (USPNC 081011.00, 089802.00),

R. bakeri Tkach, Kuzmin and Pulis, 2006 (USPNC 096379.00, 096381.00), *R. bufonis* (Schrank, 1788) Stiles and Hassall, 1905 (USPNC 027065.00), *R. chamaeleonis* (USPNC 059095.00), *R. elegans* Gutiérrez, 1945 (USPNC 084920.00, 087516.00), *R. eustreptos* MaCallum, 1921 (USPNC 042118.00), *R. füelleborni* Travassos, 1926 (USPNC 032536.00, 083796.00; CNHE 001975, 3771, 3776), *R. cf. fuscovenosa* (CNHE 3631), *R. hermaphrodita* Kloss, 1971 (USPNC 08525.00), *R. hylae* Johnston and Simpson, 1942 (USPNC 091190.00), *R. joaquinensis* Ingles, 1935 (USPNC 088047.02), *R. kuzmini* Martínez-Salazar and León-Règagnon, 2007 (CNHE 05807, 5808, 5809, 5810, 5811; USPNC 99550.00), *R. lamothei* Martínez-Salazar and León-Règagnon, 2006 (CNHE 5375; 5376-5378, 5380), *R. leonae* Martínez-Salazar, 2006 (CNHE 5543, 5444, 5445, 5446-5449), *R. nipponica* Yamaguti, 1935 (USPNC 091354.00), *R. ranae* Walton, 1929 (USPNC 088586.00, 089190.00), *R. savagei* Bursey and Goldberg, 2005 (USPNC 094848.00; CNHE 5034), *R. pseudospherocephala* Kuzmin, Tkach and Brooks, 2007 (USPNC 098146.00), material originally assigned to *R. cf. sphaerocephala* Goodey, 1924 (CNHE 001986, 002057, 002227, 002284), and *R. vellardi* Pereira, 1928 (CNHE, 142-5).

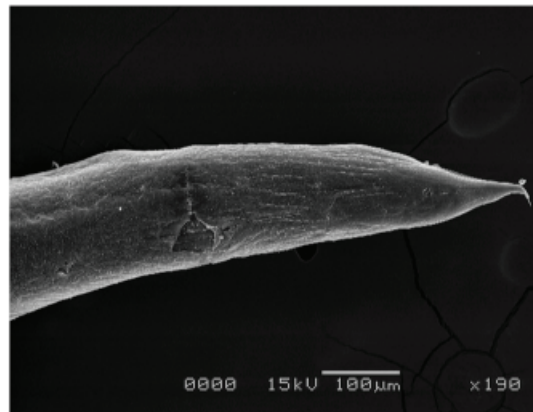
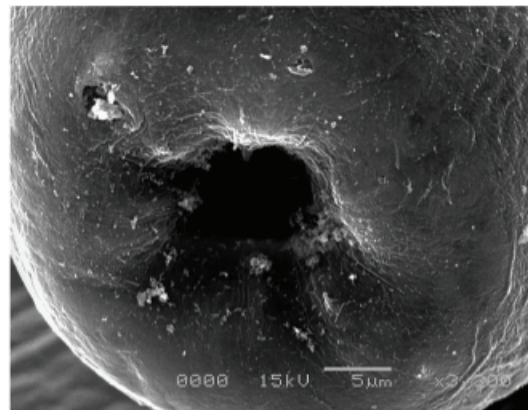
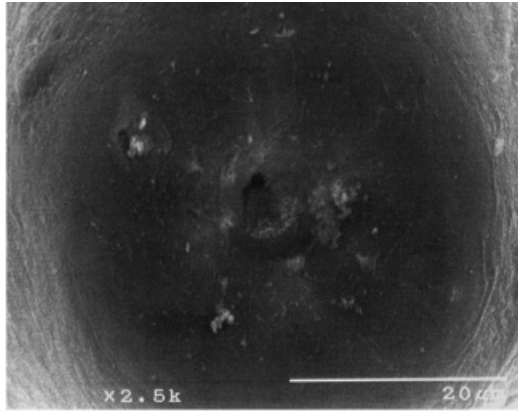
Description

Rhabdias manantlanensis n. sp. (Figs. 1 – 10)

Description based on 11 gravid individuals (measurements on 8). Body cylindrical. Body length 6.48-9.64 (7.85 \pm 1.13) mm, maximum width 175-239 (203 \pm 26). Anterior end truncated, posterior end tapered with terminal point. Body cuticle typically not swollen or only slightly swollen, thin and smooth. Oral opening oval, surrounded with 6 weakly developed lips: 4 submedian situated close to the edge of oral opening, and 2 lateral, all with small cephalic papillae. Two small lateral amphids present near to lateral papillae. Buccal capsule well developed, cup-shape in lateral view, circular in apical view, 11-19 (13 \pm 2) depth, with 19-27 (21 \pm 2) width. Esophagus club-shaped. With a muscular corpus slightly inflated. Esophagus length 387-515 (451 \pm 38), representing 5.11-6.57 (5.79) % of the body length. Esophagus width 34-46 (39 \pm 4) at anterior region, 38-54 (47 \pm 4) at muscular region, 50-65 (55 \pm 5) at the glandular region. Posterior bulb 54-77 (67 \pm 9) wide. Inconspicuous cuticular nerve ring at 193-244 (220 \pm 17) from the anterior region of the body. Inconspicuous excretory duct, located near posterior margin of nerve ring. Intestine straight, with dark brown contents. Rectum thick-walled. Vulva near to middle body (slightly pre-equatorial), lips indistinct, distance from the anterior region of the body to vulva



Figures 1-6. *Rhabdias manantlanensis* n. sp., parasite of *Craugastor occidentalis* from Sierra de Manantlán, Jalisco, México. 1. Anterior end, lateral view. 2. Cephalic end, lateral view. 3. Cephalic end, apical view. 4. Vulva region, lateral view. 5. Tail end, lateral, view. 6. Egg, lateral view. Scale bar values are given in mm.



Figures 7-9. Scanning electron microphotographs of *Rhabdias manantlanensis* n. sp. details of the external morphology. 7. Anterior end, apical view. 8. Anterior end, subapical view. 9. Shape of the tail, sharp terminal point, ventral view.

2.86-4.57 (3.74 ± 0.52) mm, representing 41.66-51.59 (47.74) % of body length. Genital system amphidelphic. Ovaries straight, lying along intestine. Tail comparatively short, conical, 143-232 (190 ± 31) long, representing 1.48-3.27 (2.48) % of body length, with sharp terminal point.



7 **Figure 10.** *Rhabdias manantlanensis* n. sp. Body total, lateral view. Scale bar values are given in mm.

Uteri relatively large. Eggs numerous, oval, thin-walled containing fully developed larvae. Egg size 88-102 (94 ± 4) long x 43-55 (50 ± 3) wide ($n=54$).

Taxonomic summary

Type specimens: Holotype, CNHE 5804; and paratypes CNHE 5805, 5806.

Type host: *Craugastor occidentalis* Taylor, 1941 (Brachycephalidae). Symbiotype UTA A-57872. Synonymized with *Eleutherodactylus occidentalis* Taylor, 1941 (Eleutherodactylidae) (see Crawford and Smith, 2005; Frost et al., 2006).

Type locality: Puerto los Mazos, Rancho los Mojos, Sierra de Manantlán, Jalisco, México ($19^{\circ}41'18''N$; $104^{\circ}23'43''W$, 1687m).

Site of infection: Lungs.

Prevalence and intensity of infection: 1 of 2 host infected (50%), 13.

Etymology: The new species is named after the type locality, in the Sierra de Manantlán, Jalisco, Mexico.

Remarks

Rhabdias manantlanensis differs from the related species by the following characteristics: body elongated, truncated anterior end, cuticle slightly swollen (thin and smooth), 6 weakly development lips (4 submedian + 2 lateral), localization of nerve ring at 193-244 (220) from anterior end, muscular corpus slightly inflated, esophagus length / body length ratio 5.11-6.57 (5.79) %, tail relatively small, conical and with sharp terminal point, tail length/body length ratio 1.48-3.27 (2.48) %, slightly pre-equatorial vulva (vulva length / body length ratio 41.66-51.59 [47.74] %), and the typical cup-shape of the buccal capsule [11-19 (13) x 19-27 (21)].

There are 15 *Rhabdias* species recorded in the

Americas considered to be typical of anurans (see Bursey et al., 2003; Bursey and Goldberg, 2005; Kuzmin et al., 2007; Martínez-Salazar and León-Régagnon, 2007): *R. alabialis*, *R. americanus*, *R. androgyna*, *R. bakeri*, *R. elegans*, *R. füelleborni*, *R. hermaphrodita*, *R. joaquinensis*, *R. kuzmini*, *R. mucronata*, *R. ranae*, *R. savagei*, *R. pseudospherocephala*, *R. tobagoensis* and *R. truncata*. Comparison of *R. manantlanensis* with *R. mucronata* and *R. truncata* is not possible because adults of these species are unknown.

Rhabdias alabialis, *R. americanus*, *R. androgyna*, *R. elegans*, *R. füelleborni*, *R. hermaphrodita*, *R. kuzmini*, and *R. pseudospherocephala* differs from *R. manantlanensis* n. sp. in host preference because all of them are typical parasites of Bufonidae.

Rhabdias alabialis differs from *R. manantlanensis* principally by the absence of lips, buccal capsule shape (triangular vs. cup in *R. manantlanensis*), and the dimensions of the body, is larger and wider in *R. alabialis* (7.67–9.27 (7.97) mm x 260–328 (315) in *R. alabialis*) (Kuzmin et al., 2007).

Rhabdias americanus can be distinguished from *R. manantlanensis* in the dimensions of the body, being larger and wider in *R. americanus* (10.74–14.14 (12.46) mm x 210–310 in *R. americanus*), the evident cuticular swelling along the body (outer layers of cuticle inflated in *R. americanus*), the presence of a evident corpus inflated in *R. americanus* (vs. slightly inflated in *R. manantlanensis*), the dimensions of the buccal capsule is smaller in *R. americanus* (10 x 12–15 (13) in *R. americanus*), the tail length / body length ratio is larger in *R. americanus* (3.3–4.5 (4.0) in *R. americanus*) (data based on Kuzmin et al., 2003).

Rhabdias androgyna is slightly larger than *R. manantlanensis* (9.4–13.4 mm in *R. androgyna*), and is also distinguished by the presence of evident corpus inflation in *R. androgyna* (vs. slightly inflated in *R. manantlanensis*), the esophagus length is larger in *R. androgyna* (577–618 in *R. androgyna*), the evident cuticular swelling along the body (outer layers of cuticle inflated in *R. androgyna*) (data based on Kloss, 1971).

Rhabdias manantlanensis differs from *R. elegans* principally in the dimensions of the body, being larger and wider in *R. elegans* (8.07–10.25 (9.59) mm x 270–357 in *R. elegans*). In addition, the buccal capsule is smaller in *R. elegans* (7 x 7 in *R. elegans*), the swelling of the cuticle is completely inflated in *R. elegans*, the length tail / body length ratio is larger in *R. elegans* (3.25–4.59 (4.98) % in *R. elegans*), and the lips structure was not described in *R. elegans* (data based on Kloss, 1971; Gutiérrez, 1945).

The new species differs from *Rhabdias füelleborni* in body size (10– 20 mm vs. 6.48 –9.64 (7.85) mm in *R.*

manantlanensis), the presence of an evident inflated corpus in *R. füelleborni* (vs. slightly inflated in *R. manantlanensis*), and the swelling of the cuticle (cuticle swollen with irregular folds vs. cuticle slightly, thin and smooth in *R. manantlanensis*) (data based on Travassos, 1926).

Rhabdias hermaphrodita differs from *R. manantlanensis* in its evident cuticular swelling along the body in *R. hermaphrodita* (vs. slightly swollen, thin and smooth in *R. manantlanensis*), the esophagus is longer in *R. hermaphrodita* (4.33–9.17 (6.08) in *R. hermaphrodita*), and the length tail / body length ratio is greater in *R. hermaphrodita* (2.54–6.57 (4.26) in *R. hermaphrodita*) (data based on Kloss, 1971).

Rhabdias manantlanensis differs from *R. kuzmini* by the dimensions of the body, being larger and wider in *R. kuzmini* (15.15–19.19 mm x 351–542 in *R. kuzmini*). In addition, the buccal capsule is larger and wider in *R. kuzmini* (31–70 (58) x 35–47 (40) in *R. kuzmini*), the shape of the buccal capsule differs (barrel-shaped vs. cup-shaped in *R. manantlanensis*), as does the cuticle swelling (cuticle slightly swollen in anterior and terminal ends with irregular folds vs. cuticle slightly swollen, thin and smooth in *R. manantlanensis*), data based on Martínez-Salazar and León-Régagnon, 2007).

The new species differs from *Rhabdias pseudospherocephala* (= *R. spheroccephala* in Central and South America from *Chaunus marinus*, according to Kuzmin et al., 2007) in the dimensions of the body, being wider in *R. pseudospherocephala* (6.17–9.60 (7.90) mm x 290–380 (330) in *R. pseudospherocephala*). The buccal capsule is of a different shape (funnel-shaped vs. cup-shaped in *R. manantlanensis*), the length tail / body length ratio is larger in *R. pseudospherocephala* (3.7–5.0 (4.4)% in *R. pseudospherocephala*), and the swelling of the cuticle also differs (cuticle swollen principally on anterior end with irregular folds vs. cuticle slightly swollen, thin and smooth in *R. manantlanensis*) (Kuzmin et al., 2007).

Rhabdias bakeri, *R. joaquinensis*, *R. ranae*, and *R. savagei* differ from *R. manantlanensis* n. sp. by the host specificity and the presence of the post-equatorial vulvae, all of them are typical parasites of Ranidae.

Rhabdias manantlanensis differs from *R. ranae* and *R. bakeri* in body size. The new taxon is thinner than *R. ranae* and *R. bakeri* [4.99–8.24 (6.61) mm x 250–350 (299) in *R. ranae*; 6.22–10.69 (9.27) mm x 225–406 (319) in *R. bakeri* vs. 6.48–9.64 (7.85) mm x 175–239 (203) in *R. manantlanensis*]; the cuticle is inflated in *R. ranae*, and *R. bakeri*, the esophagus length / body length ratio is slightly smaller in *R. manantlanensis* [5.11–6.57 (5.79) vs. 7.3–11.2 (8.7) % in *R. ranae*, and 5.4–8.8 (6.1) % in *R. bakeri*]. *Rhabdias ranae* and *R. bakeri* also differ from the new species in the presence of a evident post-equatorial

vulvae in (data based on Kuzmin et al., 2003; Tkach et al., 2006).

Rhabdias manantlanensis differs from *R. joaquinensis* in that the body is smaller and wider in *R. joaquinensis*, the cuticle swelling in posterior two-thirds comparatively thin in the anterior third of the body with a fine cuticle with fine longitudinal striations in the anterior portion of the body, covered with irregular longitudinal and oblique folds in the posterior portion, transverse folds present in the posterior quarter of the body cuticle in *R. joaquinensis* (vs. cuticle not swollen or slightly swollen, thin and smooth in the new taxon); the buccal capsule is smaller and 6 prominent inner circle papillae are present, 10 small papillae in the outer circle, and 2 porelike amphids present in *R. joaquinensis* (vs. lips weakly developed, 4 submedian and 2 lateral, all with small cephalic papillae and 2 amphids)(data based on Kuzmin et al., 2003; Table 1).

The body of *Rhabdias manantlanensis* is larger and thinner than that of *R. savagei*, the buccal capsule is smaller in *R. savagei*, the length tail / body length ratio is larger in *R. savagei*, the cuticle is inflated in *R. savagei* (vs. cuticle slightly swollen, thin and smooth in *R. manantlanensis*), and the esophagus length / body length ratio is smaller in *R. manantlanensis* (data based on Bursey and Goldberg, 2005; Table I).

Finally, *Rhabdias tobagoensis* is a neotropical species resembling *R. manantlanensis* in general morphology (both species present a relatively large buccal capsule), and are typical for Brachycephalidae. This species was described from *Eleutherodactylus charlottevillensis* Kaiser, Dwyer, Feichtinger, and Schmid, 1995, which is distributed exclusively in Tobago, West Indies (previously confused with *E. cf. terraebolivaris* Rivero, 1961 [Moravec and Kaiser, 1995]). However, *Rhabdias manantlanensis* differs from *R. tobagoensis* principally in the body width, being wider in *R. tobagoensis*. The outer body layers are inflated in *R. tobagoensis* (vs. cuticle slightly swollen, thin and smooth in *R. manantlanensis*), the buccal capsule is slightly larger in *R. manantlanensis* [11-19 (13) x 19-27 (21) vs. 6-9 (6) x 18-21 (18) in *R. tobagoensis*], the lips structure also differs (4 submedian lips and 2 lateral lips vs. circumoral lips in *R. tobagoensis*), the localization of the nerve ring is more proximal to the anterior end in *R. tobagoensis*, the shape of the vulvar lips (lips indistinct vs. slightly elevated in *R. tobagoensis*), the esophagus length / body length ratio is slightly smaller in *R. manantlanensis*, and the length tail / body length ratio is slightly smaller in *R. manantlanensis* (data based on Moravec and Kaiser, 1995; Table I).

With respect to other species distributed in the Americas, only *Rhabdias eustreptos* (MacCallum, 1921) Chitwood and Chitwood, 1934, the American form of *R.*

fuscovenosa (Railliet, 1899) Goodey, 1924) (its original distribution is in the Palaearctic Realm, and presents a pre-equatorial vulva, see Bursey et al. (2003); however, the American specimens present an equatorial vulva, see Martínez-Salazar and León-Règagnon, 2006), *R. lamothei* Martínez-Salazar and León-Règagnon, 2006, and *R. vellerdi* Pereira, 1928 belong to the general group of species that present 6 lips and equatorial vulvae as is the condition in *R. manantlanensis*. However, based on host preference, *R. manantlanensis* differs from all 4 species, which are parasites of snakes, whereas *R. manantlanensis* parasitizes anurans (Brachycephalidae). It has been observed that species of *Rhabdias* parasites of snakes never parasitize hosts of different orders (Kuzmin et al., 2003; Martínez-Salazar, 2006; Tkach et al., 2006).

There are other species that share with *Rhabdias manantlanensis* the condition of having 6 lips and equatorial vulva, but are distributed in other geographic realms, namely *R. hylae* Johnston and Simpson, 1942, distributed in the Australian Realm, *R. japalurae*, Kuzmin, 2003 in the Oriental Realm, finally *R. bufonis* (Schrank, 1788) Stiles and Hassall, 1905, *R. bermani* Rausch and Atrashkevich, 1984, and *R. vibakari* Kuzmin, 1996 in the Palaearctic Realm. All the species listed also differ from *R. manantlanensis* by the host preference (hylids in *R. hylae*, lizards *R. japalurae*, toads in *R. bufonis*, salamanders in *R. bermani*, and snakes in *R. vibakari*).

Discussion

A single species of *Rhabdias* is rarely found in representatives of more than one host group. The host preference can be quite narrow, even at the family level (Bursey et al., 2003; Kuzmin et al., 2003, Martínez-Salazar and León-Règagnon, 2006; Martínez-Salazar, 2006; Tkach et al., 2006). For example, *Rhabdias bakeri* is typical of ranids, *Rana sylvatica* LeConte, 1825 (syn. *Lithobates sylvaticus* (LeConte, 1825), see Frost et al., 2006), and *Ra. pipiens* Schreber, 1782 (syn. *L. pipiens* (Schreber, 1782), see Frost et al., 2006) (Tkach et al., 2006). Furthermore, more than 1 species of *Rhabdias* are typical of 1 bufonid species i.e., *R. fülleborni*, *R. alabialis* and *R. pseudospherocephala* are typical from *Bufo marinus* Linnaeus, 1758 (syn. *Chaunus marinus* (Linnaeus, 1758), see Frost et al., 2006) (Travassos, 1926; Kuzmin et al., 2007).

Rhabdias tobagoensis resembles the new species, with both of them parasitizing Brachycephalidae, but *R. tobagoensis* is distributed in Tobago, West Indies. There is 1 single record of *Rhabdias cf. tobagoensis* in Mexico; however, it was found parasitizing a different host group,

Table 1. Comparison of morphometry of *Rhabdias manantlanensis* n. sp. with some related species

Species	<i>R. manantlanensis</i> n. sp.	<i>R. tobagoensis</i>	<i>R. joaquinensis</i>	<i>R. savagei</i>
Reference	Present study	Moravec and Kaiser, 2000	Kuzmin et al., 2003	Bursey and Goldberg, 2005
Host	<i>Craugastor occidentalis</i>	<i>Eleutherodactylus charlottevillensis</i> ⁺	<i>Rana aurora</i>	<i>Rana cf. forreri</i>
Realm	Neotropical	Neotropical	Nearctic	Neotropical
Lips structure	6 lips	6 lips	6 lips	4 lips
Body length (mm)	6.48-9.64 (7.85)	7.34-7.56 (7.34)	3.67-5.67 (4.25)	4.2-5.3 (4.8)
Body width	175-239 (203)	408-476 (476)	260-418 (260)	255-306 (276)
Buccal capsule depth	11-19 (13)	6-9 (6)	7-12 (9)	18-24 (20)§
Buccal capsule width	19-27 (21)	18-21 (18)	10-12 (11)	12-18 (14)
Esophagus length	387-515 (451)	476-530 (530)	485-518 (503)	366-415 (394)
Esophagus length compared to the body length*	5.11-6.57 (5.79)	6-7 (7)	8.7-13.6 (12)	7.83-8.71 (8.2)
Anterior end esophagus width	34-46 (39)	Not stated	22-27 (25)	Not stated
Muscular esophagus width	38-54 (47)	Not stated	31-47 (40)	Not stated
Glandular esophagus width	50-65 (55)	Not stated	27-37 (34)	Not stated
Bulb width	54-77 (67)	Not stated	37-55 (48)	43-52 (48)†
Position of the vulva compared to the body length*	41.66-51.59 (47.74)	45.36-48.80 (48.22)‡**	63.9-74.1 (70.6)	59.52-60.37 (60.41)
Vulva position	Equatorial (Slightly pre-equatorial)	Equatorial (slightly pre- or post-equatorial)‡	Post-equatorial	Post-equatorial
Tail length	143-232 (190)	210-276 (276)	115-203 (180)	171-201 (192)
Tail length compared to the body length*	1.48-3.27 (2.48)	2.86-3.65 (3.76)	3.0-5.0 (4.3)	3.79-4.07 (4)
Egg length	88-102 (94)	102-117 (108)	90-102 (98)	80-92 (87)
Egg width	43-55 (50)	48-57 (54)	47-55 (52)	46-55 (50)

*The original record was *Eleutherodactylus cf. terrabolivaris*, however its specimens correspond with previously confused with *Eleutherodactylus charlottevillensis*.

*Expressed as percentage.

§In diameter.

†Maximum width at posterior end.

**Ratio based on the maximum and minimum measurements present in the original description.

‡ In the original description mention that the vulva is situated near middle body (slightly pre- or postequatorial).

i.e., *Dendropsaphus microcephalus* Cope, 1886 (Hylidae) (syn. *Hyla microcephala* (Cope, 1886), see Frost et al., 2006) in Veracruz State (Goldberg et al., 2002). Due to the conservative morphology of *Rhabdias*, some species can be misidentified (see re-determinations on Kuzmin et al., 2003, Tkach et al., 2006; Kuzmin et al., 2007). The specimens reported as *Rhabdias* cf. *tobagoensis* by Goldberg et al. (2002) could correspond to other species of the genus; however, the Mexican specimens are not available for re-examination. It is necessary to recollect this lung worm of the same host species in the Tuxtla region, Veracruz State, to clarify the identity of this record, using other sources of characters such as SEM or using molecular data.

In the only study regarding the helminth fauna of Brachycephalidae in Mexico, the records from *Craugastor rhodopis* (Cope, 1867) (syn. *Eleutherodactylus rhodopis* Stejneger, 1904), in Veracruz State, Mexico are described (Goldberg et al., 2002). These authors reported the infection of 1 digenean, *Gorgoderina attenuata* Stafford, 1902, 5 nematodes, *Aplectana incerta* Caballero, 1949, *Cosmocerca podicipinus* Baker and Vaucher, 1934, *Oswaldocruzia* sp., *Porrocaecum* sp. (larva), and *Strongyluris* sp.; and 1 acanthocephalan, *Centrorhynchus* sp.; they did not find lung worms in this host species.

This host group present a geographic distribution that is strongly influenced by humidity, reasons why microendemic species are commonly restricted to small highland habitats of the mountain ranges of Middle American (Campbell, 1999). For this reason, and considering the host specificity observed in species of *Rhabdias*, it is possible that the geographical distribution of *Rhabdias manantlanensis* is restricted to Western Mexico (where this endemic anuran is located).

According to Crawford and Smith (2005), *Craugastor* dispersed into northern Central America from South America in the early Paleocene; based on this hypothesis and considering the host preference of species of *Rhabdias*, it is possible that the origin of this new rhabdiasid could be Neotropical, although this hypothesis needs to be corroborated with a molecular phylogenetic analysis of the species of the *Rhabdias*.

Rhabdias manantlanensis is the first species described from an endemic Mexican Brachycephalidae and the third *Rhabdias* species recorded in the Sierra Madre del Sur (Martínez-Salazar, 2006; Martínez-Salazar and León-Règagnon, 2007). The Sierra Madre del Sur is home to many endemic organisms, and represents the highest biodiversity of amphibians and reptiles in Mexico (Flores-Villela, 1998). Richness of these vertebrates in this zone of the country suggests the existence of Rhabdiasidae still waiting to be discovered. Additional studies on the parasite

fauna of the Sierra de Manantlán, and vertebrates, need to be conducted.

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